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SCIENTIFIC PROPHECY.

PROPHECY is the prediction of an event—the declaration of something to come. When future events—either in the history of the world or in the life of man—have been foretold from no known data and from no law the prophecy must have been divine, for none but God can know the future of man. When such events in the history of nature and in the life of matter have been predicted from known data and from established laws, the prophecy is human and scientific. Every science in its growth passes through three stages. First, we have the stage of observation, when facts are collected and registered by many minds in many places. Next, we have the stage of generalisation, when these well-ascertained and carefully-verified facts are arranged methodically, generalised systematically, and classified logically, so as to deduce and elucidate from them the laws that regulate their rule and order. Lastly, we have the stage of prophecy, when these laws are so applied that events can be predicted to occur with unerring accuracy. Astronomy is said to be the only science which has thoroughly reached the last stage. Other sciences are in various stages of growth. Electricity in some branches has reached the third stage, but in many branches it is still in its infantine period. Astronomy predicts eclipses, transits, occultations, for any period in the future, and the "Nautical Almanack" is the most wonderful example of prescient knowledge; a sailor may go away for a five years' cruise, and yet in this book he will find every event in the motion of the planets, the movements of the tides, the rotation of the moon, the eclipses of the sun, &c., faithfully and unerringly foretold. But Astronomy has produced greater wonders than these. The planet Uranus was found to suffer from some slight disturbances in her path round the sun. Adams in England and Le Verrier in France simultaneously and independently, from the known laws of gravity, predicted the existence and position of another unknown planet. Galle, of Berlin, directed by Le Verrier, found the planet in the spot indicated, and it was called Neptune.

Newton, the grandest scientific man the world has perhaps ever seen, and the founder of the laws that led to the prophecy just narrated, in his investigations on light, predicted the fact that the diamond was formed of some combustible material—from its very high index of refraction. The combustion of diamond is now an ordinary, though expensive, lecture experiment. Light has given us one or two other scientific prophecies. Poisson, from theory, pronounced that in the case of an opaque circular disc the illumination of the centre of the shadow caused by diffraction at the edge of the disc would be precisely the same if the disc were altogether absent. Arago proved this to be true. Again, Sir William Hamilton predicted that in biaxial crystals there were four points where the refraction of the crystal upon an incident ray produced a continuous conical envelope. Dr. Lloyd took a crystal of arragonite, and, following Hamilton's directions, discovered what the mathematician had predicted.

Whewell predicted from theory that there must be a certain point in the North Sea, midway between Lowestoft and the coast of Holland, where there was no rise or fall of the water, because the crest or high-water mark of the tidal wave, and the trough or low-water mark of the same wave reached the same point at the same time, but by different routes. Captain Hewett, R.N., found that it was so.

Electricity has its prophets. Faraday, examining Sir Charles Wheatstone's beautiful experiment on the velocity of Electricity by means of a rotating mirror, said—"If the two ends of the wire in Professor Wheatstone's experiments were immediately connected with two large insulated metallic surfaces exposed to the air, so that the primary act of induction—after making the contact for discharge—might be in part removed from the internal portion of the wire at the first instant, and disposed for the moment on its surface jointly with the air and surrounding conductors, then I venture to anticipate that the middle spark would be more retarded than before. And if those two plates were the inner and outer coatings of a large jar or Leyden battery, then the retardation of the spark would be much greater." The experiment was not made for sixteen years. It was then shown as the explanation of the retardation of the current in our subterraneous and submarine wires.

Sir Francis Ronalds, with wonderful prescience, had in 1823—fifteen years before Faraday—suggested "the probability that the electrical induction which would take place in a wire enclosed in glass tubes of many miles in length (the wire acting like the interior coating of a battery) might amount to the retention of a charge, or at least might destroy the suddenness of the discharge." Faraday's prophetic vision and Ronalds's far-sighted knowledge are verified in every working cable. The accuracy with which our cable repairers are directed by our electricians to the spot where the wire is broken, the exactitude with which the working speed of a cable is predicted, the unfelt and invisible super-

vision which is exercised over the care and maintenance of our telegraphs,—even though they pass through distant countries and different climes,—are evidences that Electricity, in this particular field, is approaching the last and prophetic stage of its growth. This field is resistance, and Ohm is its prophet.

THE VOLTAIC BATTERY.

A Course of Six Lectures,

By Dr. JOHN HALL GLADSTONE, F.R.S.,

Fullerian Professor of Chemistry, Royal Institution.

Delivered at the Royal Institution of Great Britain.—Christmas, 1874-5.

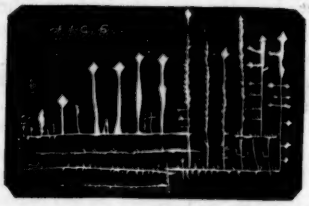
Lecture II.—The Replacement of Metals.

(Continued from page 30.)

I will now take a little bismuth. It is a metal with which you are not so familiar as with silver. We will take the chloride of bismuth, and put into it a little piece of zinc. In fact, this metal zinc—with which we became familiar the other day—will turn out almost all the common metals with which you are acquainted. A very powerful thing, indeed, is this metal zinc, and we shall use it for turning out lead, and tin, and bismuth, and some others. But, first of all, we will have bismuth. It is commonly a highly crystalline metal, and here it grows forward in great fringes. There are other metals which do the same. I spoke of silver growing in fringes, and so it does when it is very strong; but we can hardly get this bismuth to show itself in any other way. You now see the fringe of the bismuth on the screen. How different this is from the silver! You see these currents. You may see something slowly moving along—currents in the liquids, and the crystals go on growing before your eyes. Let us try another part of the metal. Here it is, with the fringe growing in all directions.

We will now take the metal thallium, which is a very rare metal, and one that has been only recently discovered. In fact, it is one of the very newest of the group of metals—the youngest born of the family, as far as our human knowledge of them is concerned. We will see how this thallium grows into crystals. I use it because it differs somewhat in appearance from the others. Some of you may know of this thallium, as it has been called, having been discovered by the peculiar green light which it emits in burning. You see how it grows in spikes, which is not the case with silver. You see this forest of pines growing up, and starting in various directions, and you see the thallium growing elsewhere into something like fern leaves. In another part it is like the fringes which we saw in the bismuth. Here come some grand pines pushing themselves forward into the liquid. We shall see these grow more rapidly with some of the other metals. We will take lead next. On the table is a large specimen of what is called the lead-tree. In order to produce this, all you have to do is to take a piece of zinc and just suspend it in a solution of acetate of lead, or any salt of lead you please. Acetate or sugar of lead is, however, that which is most easily procured. Put some zinc into the solution, and it is well to add a little acid, and lead will be deposited on the zinc. This lead-tree has been growing for some weeks, and you can see the large branches of lead on it. In fact, I should think that it had taken all the lead out of the solution, and that there is nothing but acetate of zinc remaining. We can easily set another going. You can easily procure a bottle of clear glass, fill it with the solution, and then tie a piece of zinc in it by means of string. The piece of zinc is allowed to hang thus in the solution of acetate of lead. You can do it, perhaps, a little more artistically by allowing the zinc to hang in the middle of the bottle, for it is well to have everything neatly done. I already see that the plate of zinc is covered with little spangles of bright metal. You will see what it has done by the end of the lecture, and we will let it stand that you may examine it also another day.

We will now show you some tin by means of the electric lamp and microscope. There are the crystals of tin forming on zinc. They are becoming thicker, rather than growing in length. One of them is moving about, probably with its own weight. They are becoming thick at the end. I will call your attention to one thing now before us: it was not observable in the silver, because we did not get the fern leaves formed in that case; but if you had seen the fern leaves of silver you might have noticed that the fronds of the crystals always started at an angle of 120 degrees, but here, in the



Tin crystallised.

case of tin, these cross-pieces are at right angles: the branches grow at right angles to one another, and they tend to form great cubes at the end. You see these crystals growing into cubes, so that we have a totally different geometrical character in the crystals of tin from what we had in the crystals of silver. In fact, it is one of the beauties of this subject, that if you take different metals you see a different kind of natural architecture going on. You will see that one metal will affect a certain angle, while another affects a different angle; and it is interesting to see, by means of the microscope, how beautiful that natural architecture is. When it is growing before your eyes you see minaret after minaret, and pinnacle after pinnacle, being formed, and you observe how true the form is, and how one crystal is exactly like another. Sometimes you might imagine that the growth of the crystals was the advance of different squadrons of soldiers, one behind the other, going forward towards the enemy. You see how these thick pieces are growing into large, strong crystals.

We might go on, and show you a great number of other metals in the same way. We have here a preparation of gold made before the lecture, and we will put it in and show you the effect, for gold grows rather slowly. Still it is very interesting to look at. You can see the crystals, and also the

yellow solution of gold. You see how the solution has been swept white where the crystals have been formed, and how they have cleared out the yellow from various places. Here is a long thread of crystal grown out in various ways. It has bubbles of hydrogen formed about it, but we cannot help that. Here are two patches of gold that have been growing in a crystalline form. There is another kind of gold which looks very different, and we will have a look at it, for it is more like the way in which gold most frequently appears. It is growing out in this regular sort of forward growth. We often see strange things taking place: for instance, I have often noticed that the gold salt will crystallise on the microscope slide in long, thin, needle-shaped crystals, and then the crystals of gold will grow towards the crystals of the salt; and we find that the transparent crystals of the salt are eaten up, as it were, by the gold crystals which feed upon

Gold crystallised.

them. The first time I studied this appearance particularly, I saw what I described in my notes—for want of a better term—as a caterpillar crawling along the edge of the liquid. If you watch the edges of the liquids you will often find beautiful effects. In my observation a piece of gold had floated out away from the rest—a piece of gold crystal I did not know what would happen when this caterpillar came up to it. It went on growing in the same direction, and directly it touched the loose metal it stopped, and grew no more. But the gold which had been separated was a conductor, and took up the action which had been going on in the caterpillar; so presently I began to see little sprouts of crystals from the end of it. These are the kind of things which you will see when you examine such preparations.

Now, I am afraid that I must draw upon your imagination very largely. I want you to think of what is taking place in the liquid when such a growth as those which we have seen by the microscope is happening. Of course it is very easy to imagine one metal turning out another: that must be just a chemical change, in the first instance. The zinc turns the gold out, but then directly the gold begins to grow forward in the liquid; and why is it that the fresh gold is deposited on the projecting pieces of gold, instead of being deposited on the zinc itself? And that happens, also, in all the other cases—with silver, with tin, and every other metal. There is first, then, chemical action, resulting from what we call chemical affinity or chemical force—one metal turning another out, and putting itself in its place. But directly we have that, we have what we saw in our last lecture to be necessary for voltaic action; we have two metals touching one another. We have zinc and gold, or zinc and copper, or whatever the case may be, and we have a salt between them, so that we have, as it were, a small cell, like the large one which gave us all those wonderful phenomena in the last lecture. Now, what is happening? Well, this zinc is dissolving; and I hope that even the youngest girl or boy here will remember that whenever one metal makes its appearance from a solution the other metal dissolves away at the same time. In all those cases which we saw on the screen, one metal was dissolved while the other was being deposited. You cannot, you know, put somebody else in the place which is occupied by any boy here without turning the first boy out of his place. But, while the zinc is dissolving in one place, how is it that the gold is being deposited in another? What is taking place in the liquid between? Well, it is a great thing if you can have your mind so tutored that you can form to yourselves ideas of things which you cannot see, and carry your thoughts forward; and the young can often do this better than those who are more advanced in life. But it is important so to control our imagination that we may have it firmly in hand, and so bridled that it may not run away with us, but may serve as a good horse, to carry us swiftly and safely along. Let us try to use our imagination in this way.

In the first place, we have a chemical force produced, and then a voltaic force. In this instance it seems that the chemical force is produced first; but I will say a little more about that afterwards, and perhaps we may find that the two forces are twin sisters after all. Let us see whether there is any action going on within the liquid. I will endeavour, by experiment, to show you that the solution is doing something or other. I have here an amalgamated zinc plate, such as I had at the last lecture, and here a small platinum plate, and they are joined together by a long wire. Here we have a magnet very finely suspended, and the two ends are marked by different colours. The magnet is placed just over the sulphuric acid in this glass vessel, and is now taking the position of the magnetic meridian. I put in the two connected metals, one on one side, and the other on the other. Let us see what the magnet does. It at once turns round. There, it begins to swing—to turn away from its position, just as our magnet was turned out of its place in the last lecture by means of the wire. You may take my word for it that the magnet was not turned out of its place by a wire in the present instance, but that it was what was

passing in the liquid itself which affected the magnet. Here is an arrangement in which the liquid itself is in a long tube that winds round a magnet; and we shall find that this long tube is capable of deflecting the magnet, just as the wire deflected it on a former occasion. Thus, then, we see that there is something taking place in the liquid itself. It is not necessary, in these experiments on the replacement of metals, that the junction within should be the liquid itself. If the junction between the copper and the zinc were outside, the result would be the same. Here is a plate of copper, and here a little wire of silver. The copper is in nitrate of copper, and the silver is in nitrate of silver, and the arrangement has been standing for some time. I will just take the two metals out. You see they have been joined by this wire at the top. There has been no acid used here, but each plate has been in a solution of its own salt—the copper in a copper salt, and the silver in a silver salt; and the two liquids can get at one another through a porous diaphragm. You see that beautiful display of crystallised silver. Some of the crystals which are formed in that way are among the finest possible. Here is an instrument which Mr. Tribe and I have made for some experiments of our own. Its internal construction cannot be seen, for it is not of glass as the other was; but there you perceive the beautiful forms of lead upon the leaden plate. Some of the lead has dropped as I have been lifting it up. Probably if it is put in the ray of the lamp you will see the forms better. There are the lead crystals, or, more properly, leaves of lead. Just to show you that there is a current passing through this wire, as well as a current inside, I will pass the wire along the suspended magnet, and I dare say—without the loss of a moment—we can make it clear. Now you see that it has made the magnet start, and if I remove it the magnet falls back again. There is some change then—some strange force that is going all round this wire, such as was going round the wire that you saw at the last lecture; and, as I showed you just now, there is a similar force going through the liquid itself. Now what is it that takes place? I told you that every liquid decomposed in this way was a salt or acid, and was formed of two parts. It is made of a metal, and something besides the metal—the sulphuric element, or whatever it may be. Now, how are we always to get the metal to one particular place? Is there a sort of constant pelting of the metal through the liquid? No, nothing of the kind. There is not a single particle of metal going through the liquid in that way. And when the hydrogen formed upon the copper plate, while the zinc dissolved, you did not see the hydrogen flowing from the zinc plate to the copper plate. Then how does it get there? Well, I will try to show you how, but I do not know whether I can make it at all intelligible to you; but, if the time will only allow me, I will try. I have endeavoured to illustrate it in this way. We will take a series of balls, in pairs, and we will suppose that each pair is composed of copper and the sulphuric element. We want to know how it is we can have the copper always going off—always separated at the one end. These red balls represent the copper, and the yellow the sulphuric acid, and the blue represents zinc. We can easily imagine that the zinc should exercise some kind of push, or stroke, or vibration, which shall go through the liquid, and cause the copper to fly off at the other end. But what is to happen next? We take another zinc ball, and begin to act in the same way; but in this case it will be the sulphuric element going off next at the other end. Well, we must suppose that there is some change of position, and that instead of the sulphuric element being ready to fly off at the next stroke, there has been a turning round, such as I am making with these coloured balls by means of my hand, and then at the next stroke of the zinc it will be another copper ball that flies off.

We can imagine such an alternation taking place each time, and so we can get all our copper sent off at the one end. [The action in question was further illustrated and explained with the aid of a working diagram constructed of paper.] I might illustrate it, also, by the way in which you sit upon these seats. Suppose you were under some potent obligation always to keep arranged alternately boy and girl, and yet it were necessary that all the boys on the bench should come out at one end of it: it could be managed by each girl and boy changing places at each move, and a fresh boy from another quarter coming in at the other end of the bench as a companion to the last girl, in the place of the one that had passed on. But I think I have said sufficient to indicate my meaning, and to give you some conception of how these metallic crystals may grow up. It is about the most difficult matter that I shall have to bring before you during the whole course—to make you understand at all what is taking place in these liquids; but the phenomena themselves are exceedingly beautiful, and you will have an opportunity of seeing some of the crystals under the microscopes outside, and you will be able to repeat many of the experiments at home. I hope that if you find any difficulties in doing so you will come to me, and ask me to explain more fully the experiments which I have brought before you to-day.

THE ROYAL INSTITUTION.

Dr. Tyndall has just commenced a course of lectures on subjects connected with electricity, which are delivered and illustrated in the way characteristic of that unrivalled lecturer. We have much pleasure in giving the notes of the first lecture. The rest will follow in due course. Professor Tyndall's illustrative experimental apparatus was of the simplest character. His electroscope was a light lath about three feet long, balanced on the rounded end of an egg. The effects of repulsion were shown by suspending with long silk thread two india-rubber balloons—children's toys—close to each other, and exciting them with the hand. His sources of electricity were glass jars, native amber, rock crystal, india-rubber, ebonite combs, gutta-percha, &c. The conduction of the human body was shown by the suspension and insulation of his active and able assistant, Mr. Cottrell, whose nose, to the great amusement of the audience, was made the attractive point of a light balanced scale. Many of the experiments were historical, and all were of that simple character which admit of easy repetition at home.

Notes of a Course of Seven Lectures on Electricity.
By Professor Tyndall, LL.D. F.R.S.

Lecture I. *February* 4, 1875.

1. Many centuries before the Christian era it had been observed that yellow amber (*Elektron*), when rubbed, possessed the power of attracting light bodies.

2. The human mind soon began to show its discontent with the mere fact of observation, desiring something beyond it. What, it was asked, was the cause of this power in rubbed amber? Thales, the founder of the Ionic philosophy (B.C. 580), imagined the amber to be animated by a kind of life.

3. So matters remained for nearly 2200 years. In 1600 Dr. Gilbert, physician to Queen Elizabeth, whose attention had been successfully devoted to magnetism, passed from it to electricity. He showed that not only amber, but various spars, gems, fossils, stones, glasses, and resins, exhibited, when rubbed, the same power as amber.

4. Robert Boyle (1675) suspended rubbed amber, and proved that it, which attracted other bodies to itself, was in turn attracted by a body brought near it. He also observed the *light* of electricity, a diamond with which he operated being found to emit light when rubbed in the dark.

5. The tendency to physical theory showed itself in Boyle. He imagined that the electrified body threw out a glutinous or unctuous effluvium, which laid hold of small bodies, and in its return to the source from which it emanated carried them along with it.

6. The human mind was at this time in the condition of a wound-up spring from which the detent had been removed. The desire and capacity for investigation came suddenly into play. Otto von Guericke, contemporary of Boyle, and inventor of the air-pump, augmented the electric power previously obtained, and devised the first electrical machine, which was a ball of sulphur about the size of a child's head. His sphere of sulphur turned by a handle and rubbed by the hand emitted light in the dark.

7. Von Guericke also noticed that a feather, after having been once attracted towards his sulphur globe, was afterwards repelled and kept at a distance from it, until, having touched another body, it was again attracted. He also observed the hissing of the "electric fire," and that a body brought near his excited sphere became electrical, and was attracted by another body brought near it.

8. The members of the Academy del Cimento examined various substances electrically, proving smoke to be attracted, but not flame. Flame, they found, deprived an electrified body of its power.

9. They also proved fluids to be sensible to the attraction of amber; showing that an eminence was formed when rubbed amber was brought over the surface of a liquid, the liquid being finally discharged against the amber.

10. Sir Isaac Newton rubbed a flat glass, and caused light bodies to dance between it and a table. He also noticed the influence of the rubber in electric excitation. His gown, for example, was much more effective than a napkin. Newton imagined that the excited electric emitted an elastic fluid which penetrated glass.

11. Electric light *in vacuo* was first observed by Picard in 1675. While carrying a barometer from the Observatory to the Porte St. Michel in Paris, he observed light in the vacuous portion. Sebastien and Cassini observed it afterwards in other barometers. John Bernoulli devised a "mercurial phosphorus," by shaking mercury in a tube which had been exhausted by an air-pump. This was handed to the King of Prussia—Frederick I.—who awarded for it a medal of forty ducats value. The great mathematician wrote a poem in honour of the occasion.

12. In 1705 Hauksbee made some celebrated experiments on this subject before the Royal Society. He also observed light in vacuo produced by the approach of an electrified body to an exhausted glass globe, and remarked on the colour of the light.

13. Dr. Wall (1708) operated with large elongated pieces of amber. He found *wool* to be the best rubber. "A prodigious number of little cracklings" was heard on rubbing the amber, and every one of them produced a flash of light. By holding one's finger at a little distance from the amber, a large crackling was produced, with a great flash of light succeeding it. "This light and crackling," says Dr. Wall, "seems in some degree to represent thunder and lightning." (*Phil. Trans.*, 1708, p. 69.) This was the first allusion to thunder and lightning in connection with electricity.

14. Stephen Gray (1729) experimented with a glass tube stopped by a cork. When the tube was rubbed the cork was found to attract light bodies. "Much surprised," Gray "concluded that there was certainly an attractive virtue communicated to the cork." This was the starting point of our knowledge of electric conduction.

15. A fir stick, four inches long, and stuck into the cork, was also found to attract. Gray first lengthened his sticks and then passed on to packthread and wires. Through the thread from the top window of a house he attracted light bodies at the bottom. Suspending a hempen line by loops of packthread, he failed to transmit the electric power. Suspending it by loops of silk he sent the "virtue" through 765 feet of the line. He thought the silk effectual because it was *thin*; but on replacing a loop of it, which had broken, by a still thinner wire, he obtained no action. Finally, he came to the conclusion that his loops were effectual, not because they were thin, but because they were *silk*. This was the starting point of our knowledge of insulation.

16. Gray also found that the mere approach of an excited tube was sufficient to produce attraction at a distance. This action will subsequently be considered under the head of *electric induction*. He experimented on fluids and on animal bodies, using in the first instance soap-bubbles formed of Thames water, and in the second a boy suspended by hair lines in a horizontal position. He was not aware of the part played by moisture in his rods, lines, and tissues.

17. Gray suspended pokers, tongs, and fire-shovels by silk strings, and electrified them. To facilitate the process he attached to them tassels of thread, and these simple devices led up to the prime conductor of the electrical machine. Gray also observed the electric brush, snappings, and sparks, and makes the prophetic remark that "though these effects are at present only minute,

it is probable that in time there may be found out a way to collect a greater quantity of the electric fibre, and consequently to increase the force of that power: which by several of those experiments, if we are permitted to compare great things with small, seems to be of the same nature with that of thunder and lightning." This is much more definite than Dr. Wall.

Stephen Gray was dying when his last experiments were made. Unable to describe them himself, he dictated an account of them to Dr. Mortimer, Secretary of the Royal Society, the day before his death.

18. Du Fay (1733 to 1737) extended the list of "electrics" (the name given to bodies capable of being electrified). He established the influence of moisture, and conducted the electric power through 1256 feet of moist packthread.

19. Stephen Gray obtained *attraction* through the human body. Du Fay first obtained a *spark* from a human body. He tried to fire gunpowder and inflammable substances by this spark, but failed.

20. Du Fay announced the important discovery that there are two kinds of electricity. Gold leaf, floating in air, he found to be first attracted, then repelled by the same body. When repelled by rubbed glass it was attracted by rubbed resin, and when repelled by rubbed resin it was attracted by rubbed glass. Hence the terms *vitreous* electricity and *resinous* electricity. Du Fay proved each of them to be self-repulsive, while attractive of the other. This is the fundamental law of electric action.

21. To ascertain the kind of electricity with which a body is charged, Du Fay adopted the correct test of repulsion. Attraction is not a safe test.

21. Dr. Desaguliers (1741—42) made many sagacious observations and remarks on electricity. He found that he could electrify a wax candle, but that near the flame the electricity disappeared. He ranked pure *air* among his electrics.

23. It is now time to say that the distinction between electrics and non-electrics is really a distinction between insulators and conductors. The conductors being held in the hand and rubbed, the excited electricity immediately escaped, while it was retained upon the surfaces of insulators. When properly insulated the most perfect conductor can be electrified by friction.

ROYAL TELEGRAPHING.

THE Queen's speech is the great telegraphic event of the year. Telegraphists all over the country vie with each other in their eagerness to rapidly transmit the royal utterances at the opening and the close of the parliamentary session; and the trials of speed at the Central Station in London are regarded as the "Derby" of telegraphy. It was so in the old days of telegraphic communication, when the speech used to be signalled on the double needle instrument, and had to be let down by very easy stages indeed, when it was destined for distant towns in the North of Scotland, or the West of England, or for Ireland. Perhaps, indeed, it might have to be re-transmitted three or four times before it reached Aberdeen, and at least twice on its journey to Plymouth. Last Friday week it was signalled *direct* from the Central Station to Aberdeen and Falmouth: to the former place within the short space of twenty minutes, and to the latter in exactly half that time. It is questionable if, in the early days of telegraphy, the Queen's speech would be sent to such a place as Falmouth at all. The enormous enterprise of the press, and the vast development of the telegraphic system, have rendered a good many things both necessary and practicable which were in those days deemed impossible. For instance, the Queen's speech of the other day was transmitted to no fewer than 183 towns throughout the United Kingdom; and lest any one should suppose that these were only the important centres of commercial activity or political thought, let him consider that such places as Oban, Campbeltown, Peterhead, Wick, Thurso, and Tralee, were amongst the number. To nearly 60 out of the 183 towns referred to, the speech was signalled *direct* from London; and to the remaining 120 or so it would be completed with, in most cases, only a single re-transmission. The work of signalling commenced at 2.8 p.m., that being the moment at which the signal to "start" was received from the House of Commons. In a twinkling, the fingers which had been nervously grasping their "keys" for some minutes came down in the shape of "dots" and "dashes" to the tune of 40 words a-minute or more; and the Wheatstone transmitters, wound up to the highest pitch of eagerness, were let loose with their familiar "whirr." While we were only as yet looking on to see what it all meant, "Finished to Leicester" shouted one excited operator, and ditto to York shouted another at the same moment. This was at 2.14 p.m. to the moment; so that the 983 words of which the speech was composed were transmitted to these towns in six minutes, or at an average speed of nearly 10,000 words an hour! The great towns—Birmingham, Manchester, and Liverpool, and Nottingham, Sheffield, Leeds, and Bradford—received the speech simultaneously, on what are called the "express circuits," and to these the work of transmission was accomplished in the short space of eleven minutes. To Scotland and Ireland—including Aberdeen, Dundee, Belfast, and Cork—the speech was finished within twenty minutes; and to the great majority of places where the transmission was effected direct, within half-an-hour. By hand, on the ordinary Morse instrument, the speech was first finished to Brighton; but as two separate wires were employed in this case, the actual speed of transmission is not acurately determinable. The necessity for speedy transmission to Brighton is evident, if we consider that the telegraph has really to compete with the London evening papers, where the distance is so short, and the train service so swift. The absolutely quickest transmission by hand was to Southampton, Reading, and Bath, where a speed of 44 words a-minute, or upwards of 2600 words an hour, was attained. This, we may explain, is equal to about 75 ordinary telegraph messages an hour; although it is probable that abbreviations were largely resorted to, both in the hand and Wheatstone processes of transmission. We have said that the speech contained 983 words. Making due allowance for stops and punctuation, this represents 4800 letters; and any telegraphist with a statistical craze could easily tell us the number of separate movements involved in transmitting this quantity of matter. The word

"Paris" is usually accepted as the standard in such calculations; and working on this basis, it would be found that upwards of 50,000 separate holes would have to be punched on the Wheatstone slip before it was ready for passing through the transmitter, and that nearly 14,000 separate symbols would be recorded in ink at the receiving stations. Similarly, all the clerks who transmitted the speech by hand, would have to make 14,000 depressions of their keys, representing some 10,000 dots and 4000 dashes. It does not detract from the interest or the credit of the feat performed at the Central Station last Friday week that the operators concerned in the transmission of the Queen's speech were mostly drawn from among the young ladies of the establishment. There is, indeed, quite a pleasing appropriateness in the arrangement by which the gracious utterances of our most Royal Lady should be transmitted to the uttermost parts of her Majesty's dominions by female hands.

Notes.

We have to record, with much regret, the death, on January 23rd, of General Meydam, the Director-General of Telegraphs of the German Empire.

General Eckert, who visited Europe two years ago with Mr. Prescott, has suddenly resigned the General Superintendentship of the Western Union Company's lines, in America. He is about to manage, as President, the Atlantic and Pacific Telegraph Company's business, the chief competitors of the Western Union Company; and it is reported that a great and bitter telegraphic contest is about to commence in that country between these rivals.

One of our London contemporaries heads its short condensed summary of news with the following specimen of Neology:—"Telegraphized News Notes."

The Eastern Telegraph Company have just opened a new route to Egypt across France, *via* Marseilles and Malta. They have leased a special wire for this purpose from the French Government.

We learn from the *Athenæum* that "Attention has been called by M. Max Paulet to the destruction of wooden railway-sleepers, laid in ballast, in spite of attempts to preserve the wood by injecting sulphate of copper. His experiments tend to show that the action of this metallic salt on the ligneous tissue produces a compound which is not absolutely insoluble in pure water, and is soluble to a notable extent in water charged with carbonic acid. After having lain for some time near the iron rails, the wood was found to contain a considerable proportion of iron, whilst away from the neighbourhood of the rails the carbonate of lime derived from the ballast took the place of the copper-salt; and although the lime-compound is not itself a septic agent, it yet acts prejudicially by removing the preservative medium. From these results it appears that wood thus prepared is far from being a durable material for construction of permanent way." This fully confirms the experience of the Boucherising process upon telegraph poles in England, especially in the chalky districts. We give an abstract of M. Paulet's paper at p. 48.

We have pleasure in calling the attention of our readers to a course of fifty lectures, on Electricity and Magnetism, which are being delivered by Prof. Foster at the University College, and which are advertised in our first page.

The cable between England and Guernsey was repaired on the 7th inst.

The cable between the Lizard, Cornwall, and Santander, in Spain, is broken down, and the *Caroline*, one of Mr. Henley's ships, which is on the spot, is about to repair it.

Many of the officers of the late Electric and International Telegraph Company will be glad to learn that their old friend and colleague, Mr. H. Shütz Wilson, is continuing to gain laurels in the pleasant fields of Literature for which, at the transfer, he gave up the rougher paths of Telegraphy. His "Studies and Romances," published by King and Co., and "Philip Mannington," a novel published by Tinsley, are rapidly running through their first edition, and are much sought after at Mudie's, Smith's, and other libraries. Many will remember Mr. Wilson's early productions, published twenty years ago, in that pleasant and creditable but very scarce publication *Our Magazine*, produced entirely by officers of the Electric and International Telegraph Company.

The Chinese authorities are only now about to commence mining operations in the very locality referred to in an ancient Chinese history, some 2000 years old, as being the spot where the loadstone was first discovered in China.

The following story is going the round of the papers:—A clerk in the Telegraph Office, No. 145, Broadway, New York, the other day received a message from Philadelphia for him to transmit to Paris. It had to be sent *via* Duxbury in the usual way, whom he could not make to hear. So he wired to Plaister Cove, Newfoundland—"Please wake my dear colleague at Duxbury." The Plaister Cove clerk telegraphed to Valentia, in Ireland, who telegraphed to London, *and thence to Paris* (!), thence to St. Pierre, and thence, at last, to Duxbury, and this time the drowsy operator was aroused. We have seen this story in other forms before.

Scientific men who read the *Times*—and who does not?—must have observed the prominence which that paper is now giving to scientific intelligence. Its Parisian correspondent is very observant and instructive, and its telegraphic information generally is of the very first order, and is most ably written.

The Union Steamship Company's steamships *Asiatic*, *African*, and *Anglian*, sailing from Plymouth on the 6th, 16th, and 26th inst., respectively, will touch at Madeira, on the outward voyage, for the purpose of receiving on board telegrams addressed to places in Cape Colony.

ON THE

CONSTRUCTION AND MAINTENANCE OF LIGHTNING CONDUCTORS.

By R. FRANCISQUE MICHEL.

Most of the lightning conductors of Paris have been neglected for so many years that they are positively dangerous instead of being useful protecting apparatus. Examined with a very strong magnifying glass, the points of the stem are blunted or burnt (a criterion of the bad condition of the communications), and the points have fallen from several—or rather, having been badly joined, the solder has failed, and they only hold together by the pins; the vibrations of the stem when agitated by the wind has worn away the connections, so that a great number are easily shaken by the hand. The contact is very bad, and consequently the preventive effect of the apparatus is absolutely null. But these great deteriorations are not confined to the stems, since the point of juncture of the conductor to the base of the stem is almost everywhere in a deplorable state. This juncture I have always found to have been made with a strap or iron collar, whose pieces are rusted, so as to render the electric communications next to nothing.

I have found the conductor, in general, composed of lengths of iron, of 15 m.m. square section, maintained in position against the buildings by cramps driven into the walls, and rivetted to the conductors. thus weakening them at certain points, and also increasing their electric resistance. The different lengths are jointed by means of a pyramidal bolt let into a notch of the same form, and, by a simple pin, their contact is deemed to be rigidly maintained.

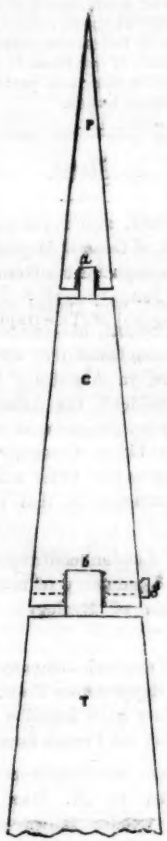
In the first place, conductors, which often attain very considerable lengths, dilate and contract in consequence of differences of temperature.* These variations strain very considerably the braces (rivetted as they are to cramps, and fastened to the walls), by causing the conductor to bend, and thus frequently the fastenings are torn out, to the general derangement of the entire apparatus. As regards the earth communication they are in no better condition: their resistance, measured by one of Wheatstone's bridges, is always much too considerable. I have even met with instances in which the conductibility may be considered null.

* In our climates the bars of the conductor may attain, in the hottest summer sun, a temperature of about 60° C.; during winter it may be as low as −20°, representing a difference of about 80°. For such a variation the bars of iron may lengthen 1-100th, say 1 centimetre for 10 metres.

These conductors may still be rendered useful and sound by repairing them in the following fashion:—

The Stem.—The old stems, if they are not too deeply eaten away with rust, and are made of one piece, may be used again, by subjecting them to the following modifications:—The platinum point so much extolled is not indispensable. One of red copper, or, better still, an alloy of 835 parts silver and 165 parts copper, may be substituted. Then the arrangement shown in Fig. 1 may be given to the stem.

Fig. 1.

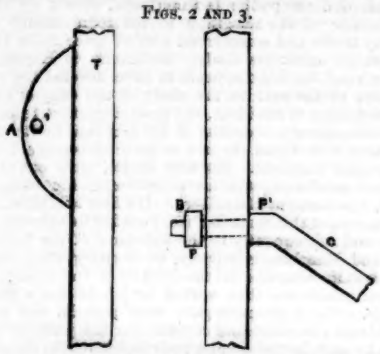


C is the trunk of a red copper cone, upon the top of which a pinnacle, P, of platinum, or copper and silver alloy, should be screwed, pinned, and strongly soldered at *a*, the whole to be screwed on to T at *b*. Then, to ensure thorough contact, I propose to insert between C and T, a kind of washer of freshly scraped lead, and to cover the entire joint with a thick layer of solder.

The Conductor.—I said that the point where the conductor joined the stem was always in a deplorable condition. The following re-arrangement presents many serviceable features. At a little above the base of the stem, say about 20 centimetres from

the roof of the building, let a flange, A, be welded, with a hole pierced through it. Through this hole the conductor, previously filed down to the proper dimensions, must be tightly passed. After scraping the iron around the hole, a washer of lead is placed

FIGS. 2 AND 3.



at P and P', and the button B, with the help of a strong layer of solder, thoroughly binds everything together. By this means an excellent joint is obtained; the contact surface is considerable, and completely protected from rust—a condition never hitherto fulfilled. If bars of iron are used for conductors, one cannot be too careful as regards their joints. That consisting of the pyramidal bolt and pin (formerly much used) is very bad, and should be entirely rejected. The jointing represented in Fig. 4 seems to afford good claim to dura-

FIG. 4.

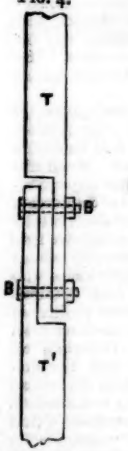
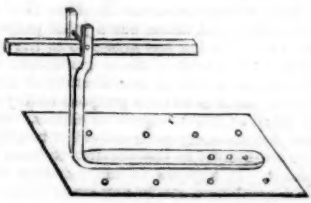


FIG. 5.



bility and good contact. On each end of the bars to be joined two flanges, about 15 c.m. long, and half the thickness of the bars, are filed out. A thin sheet of well cleansed lead is then placed between them. The whole is then firmly bolted together by bolts at B and B', and covered with solder, thus furnishing a contact of great solidity, unlimited durability, and without appreciable resistance.

The Supports.—Instead of using rivetted cramps to hold up the conductor, a model (Fig. 5) laid before the Academy of Sciences answers perfectly as a substitute. It is simply a fork in which the conductor is held fast by a pin. Being allowed to slide backwards and forwards in the fork with great facility, the conductor is allowed to dilate or contract under the influence of temperature without threatening the supports with destruction. Upon what part, however, ought the effect of such contraction or dilation to be borne?

The Compensator.—This instrument is the part designed to bear the strain, and the Academy of Sciences has proposed its use. A sketch of it is given below.

FIG. 6.

It is composed of an elastic plate, F, of red copper, well annealed—2 c.m. wide, minimum length 70 c.m., and 5 m.m. thick. The two extremities of this plate are firmly fastened to the end of the conductor-bars by the bolts and counterpieces, B B', and afterwards well covered with a firm layer of solder. When, in consequence of heat, the conductor expands, the curve of the plate F will become greater, and *vice versâ*. As to the places where they should be placed the architect will be the best judge. In general a single apparatus compensates for the effects produced by long straight lengths, and it will therefore suffice to place one at each bend. Since it is important to preserve the metallic parts of the conductor from contact with the air, it might be profitably coated all over (except the copper and alloy portion of the stem—C F, Fig. 1) with a strong coat of tar, a painting of zinc or tin filings, or a painting of metallic basis, which could afterwards be covered with another coat of more suitable colour.

Earth.—I have almost always noticed the serious fault that where the conductor penetrates the soil it is not covered with any protecting substance; so that the alternations of dryness and moisture in the soil deeply corrodes the iron, and ultimately eats it entirely through. The remainder of the underground portion of the conductor is also always in a deplorable state.

The first inconvenience may be remedied in many ways: The use of a vertical spout of tarred, boucherised, or creosoted, wood, rising a few centimetres above the soil, has long been proposed; but is it not more simple to surround this small part of the conductor with a wrapper of sheet lead? This portion of the conductor may even be well tarred, but only for a short distance, simply as far as the place where it makes a bend to enter the trough through which it reaches the sheet of water or other terminal. To guard against the second inconvenience—that affecting the portion of the conductor which winds about underground—the Academy of Science advises the use of a trough filled with broken charcoal (*braise de boulanger*), through which the conductor runs. This charcoal prevents a too rapid oxidation of the iron. Coke, well piled up, may be substituted for it; and for the trough injected wood or gutter tiles will suit admirab

When the trough has to bear a considerable pressure it may be made of bricks, without mortar, to allow the moisture of the soil to readily penetrate. It is preferable, although the conductor be lengthened, to carry it through the dampest plots of ground around the building.

(To be continued.)

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

Inaugural Address, by Mr. Latimer Clark, President. January 13, 1875.

(Continued from page 33.)

In 1819 Œrsted discovered the effect of the current in causing a deflection of the magnetised needle; and in 1820 Ampère proposed to construct a telegraph by means of the voltaic battery, the coil of wire, and the magnetised needle. This was followed by the long series of Faraday's wonderful electrical researches.

In 1827 Dr. Jacob Green, of Jefferson College, Philadelphia, wrote as follows:—"In the very early stage of electro-magnetic experiments it had been suggested that an instantaneous telegraph might be constructed by means of conjunctive wires and magnetic needles. The details of this contrivance are so obvious, and the principles upon which it is founded are so well understood, that there was only one question which could render the result doubtful. This was, whether by lengthening the conjunctive wires there would be any diminution in the electrical effect upon the needle. . . . Had it been found true that the galvanic fluid could be transmitted in a moment through a great extent of conducting wire without diminishing its magnetic effect, then no question could have been entertained as to the practicability and importance of the suggestion adverted to above with regard to the telegraph. Mr. Barlow, of the Royal Military Academy (at Woolwich), who has made a number of successful experiments and investigations in electro-magnetism, fully ascertained that there was so sensible a diminution with only 200 feet of wire as to convince him at once of the impracticability of the scheme."

There can be little doubt that this published opinion of so eminent a man as Prof. Barlow, which occurs in the *Philosophical Transactions*, had the effect of retarding the introduction of electric telegraphs by many years.

In the same year Ohm published the celebrated mathematical formulæ which bear his name, and had they been known and duly appreciated at the time they would at once have dispelled all misgivings as to the distance at which electrical effects might be rendered sensible. They were not, however, translated into English until 1841.

In 1828 Green, of Nottingham, published his valuable mathematical investigations of the distribution of electricity on the surface of conductors of various forms.

In 1834 Wheatstone immortalised his name by his magnificent experiment on the velocity of electricity, and by his other researches on the subject, which doubtless caused many minds to ask themselves, as Ronalds had done, "Why has no serious trial yet been made of the qualifications of so diligent a courier?"

We now approach the memorable epoch of 1837. Scientific men were in possession of every knowledge and appliance necessary for creating a perfect electric telegraph; the subject was commonly lectured on; fresh methods of communication continued to be invented, among which I will only mention that of Baron Schilling, who, in 1832, employed five wires insulated by silk, and five vertical needles.

Railways had also now come into extensive use, and the world was in every way ripe and ready for the practical introduction of the telegraph. In March, 1836, Mr. Wm. F. Cooke appears to have been present at one of these public lectures, and, struck by the adaptability of the telegraph to the requirements of railway traffic and commercial use, at once made the subject his exclusive study. Returning to England, on the 22nd April, he appears to have devoted the remainder of the year to the study of the subject and the perfection of his ideas, the most important feature of which appears to consist in the fact that he for the first time introduced the use of an electro-magnet for telegraphic purposes. His first model, made out of a musical snuff-box with an electro-magnetic escapement, was made at Heidelberg. He first exhibited an instrument of this form to Prof. Faraday in November, 1836, and subsequently to the Directors of the Liverpool and Manchester Railway, in January, 1837, with a view to its adoption on the incline of the Liverpool Tunnel, which was then worked by a rope and a fixed engine. The instrument gave sixty signals, and was considered too novel and complex for the purpose required; and, before simpler instruments could be constructed, they adopted a pneumatic telegraph.

We now arrive at the epoch of 1837, the year in which the first practical telegraphs were introduced. Several electric telegraphs were invented during this year, any of which, in the absence of others, would, without doubt, have laid the foundation of the practical telegraph. Among them those of Cooke, Wheatstone, Morse, and Steinheil require especial mention. The telegraph of Prof. Steinheil deserves notice on account of its great ingenuity and completeness. He employed only one wire, and transmitted his signals either by sound or by an alphabet of dots printed on a strip of paper, and he employed the earth circuit. His experiments were performed on a distance of several miles between the Royal Academy at Munich and Bogenhausen, and his telegraph was certainly very far in advance of any other existing at that date. His system was not, however, brought into further use at that period.

In February, 1837, Mr. Cooke, by the advice of Prof. Faraday and Dr. Roget, made the acquaintance of Prof. Wheatstone, and in June they had formed a partnership and taken out a joint patent. Much difference of opinion has arisen as to the due apportionment of the merit of these gentlemen in connection with the invention or introduction of the electric telegraph; but it is not our purpose to-day to inquire into the merit of these respective claims. Happily, abundant documentary evidence exists to enable those who take an interest in the question to form their opinions upon it. It appears to me, however, that neither of those gentlemen can in any sense claim to have been the inventor of the electric telegraph. In fact, if we except the use of the electro-magnet and the mechanical escapement, I do not find, in their inventions of this period, any important novelty of combination or of principle which appears likely to survive in that process of "natural selection," that "struggle for existence," which goes on as persistently among the productions of art as in the province of Nature. Their claim for distinction must rest rather on the energy and success with which they introduced their system into practical use, and compelled the world to recognise its merits.

By the deed of partnership executed between these gentlemen it was arranged that Mr. Cooke was to continue the entire practical management and control of their affairs, and accordingly, on the 27th of June, Mr. Cooke was introduced to Mr. Robert Stephenson, who at once took the greatest interest in the invention,

and lent it all his influence and assistance. It is gratifying to find the name of one of the fathers of the railway system thus early acting as a father to the electric telegraph.

On the 4th of July the apparatus was exhibited to Mr. Stephenson, and by the 25th their first experimental line was in operation between Euston and Camden, and was worked in the presence of Professor Wheatstone, Mr. Stephenson, Mr. Charles Fox, Mr. Brunel, and Sir Benjamin Hawes.

The system exhibited was still that of the electro-magnetic escapement and rotary dial,—the needle telegraph, which has been since so intimately associated with their names, not having been yet perfected.

At the same time Prof. Morse was occupied in introducing his electro-magnetic telegraph in America. This telegraph, from its exquisite simplicity, has come into universal use throughout the world, and has conferred immortality on the name of its inventor. The idea had long existed in his mind, and as early as 1835 he had exhibited his experiments to private friends, but there appears no published record referring to his invention earlier than a letter in the *New York Observer* of April 15, 1837, by his brother, S. E. Morse, and in this letter he speaks of the invention as requiring twenty-four wires. On the 10th of March a circular letter had been sent to certain collectors of customs and others desiring information with reference to telegraphic communication, and it was this circular which probably evoked the letter in question. On the 27th September Prof. Morse wrote a letter to the Secretary of the Treasury of the United States, which shows that he had allowed the subject to lie dormant, but he promised to have a complete apparatus in operation by the 1st January, 1838. His first experiment, over half a mile, was made on the 2nd October, 1837, and on the 6th October he filed a caveat in the patent office at Washington. I believe the first working telegraphic line erected in the United States was that between Washington and Baltimore, which began work in 1844.

(To be continued.)

Notices of Books.

A Manual of Telegraph Construction: the Mechanical Elements of Electric Telegraph Engineering. By JOHN CHRISTIE DOUGLAS, East India Government Telegraph Depôt, &c. London: Charles Griffin and Company. 1875.

THAT a manual of telegraph construction is a want which has been long felt will be admitted by every one who is in any way connected with the subject; and since the first announcements of Mr. Douglas's work appeared, we had hoped to find that, upon its publication, this desideratum would be at last supplied. We regret to state that our hopes have been disappointed. A work containing 420 pages of closely printed matter has now appeared, professing to deal with the subject; but less than 100 pages have been devoted to the treatment of it. Yet it is not to the amount of matter that we should object—for there is certainly here enough, and more than enough to satisfy even the most ravenous appetite in that respect. What we do object to is the fact that so much unnecessary extraneous matter is introduced: over 115 pages are devoted at the outset to "The General Principles of Strength and Stability," whilst over 200 follow upon the "Properties and Applications of Materials: Operations and Manipulations," leaving less than 100 for the subject of "Telegraph Construction: Maintenance and Organisation." The plea which Mr. Douglas advances for this is that "it is necessary that he (the telegraph engineer) should know the principles on which such, *i.e.* very complex frames, roofs, &c., extensive works in brick or cut stone, are built, to enable him to construct plinths of stone, and of brick with stone copes, and to fasten posts, cantilevers on, and in work built by others." Admitting this necessity, all the information required might have been condensed into one-third at the outside of the space which it is here spread over; the general principles on which he lays so much stress might have been clearly stated and briefly explained; whilst a large mass which has been most assiduously collected to form a volume might have been left in the works from which it is drawn. A reference from time to time might have been made to one or other of the numerous authors to whom Mr. Douglas expresses himself indebted. Conspicuous by its absence from the list of these is Mr. Culley's name. Although, strange to say, we meet with it no fewer than nine times—and then mis-spelt, by the way, on every occasion—is a single paragraph (No. 332) upon the subject of iron wire.

The general plan of the work can be gathered from the titles which have been already quoted of the three parts into which it is divided. That it contains a deal of useful information no one will be disposed to question; that it contains a deal more which is utterly superfluous will be admitted with equal readiness. Not the least objectionable feature in it is the slipshod manner in which the book is written. The sentences are as a rlue unnecessarily involved and complex; in many the subject is lost long before the end is reached, and almost all of any length require to be re-read before the exact drift of their meaning can be ascertained. In many of the paragraphs the same facts are stated over and over again, leaving upon the mind of the reader the impression that the author had written down the observations drawn from each successive work to which he referred, and had allowed them to remain so without any attempt to condense or mould them into a clear and compact statement.

Should ever another edition of the work be called for, we would advise Mr. Douglas to bring it within more modest dimensions, and endeavour to render the work intelligible enough to attract rather than repel the student.

Electrical Science in English and Foreign Journals.

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences. No. 1. January 4, 1875.

A Note on Magnetism, à propos of a recent communication by M. Lallemand.—By the Count du Moncel.—Because it appears from a recent note by M. Lallemand (*vide* TELEGRAPHIC JOURNAL, Nov. 15, 1874, vol. ii., p. 370) that, notwithstanding Count du Moncel's volume, numerous pamphlets, &c., his researches on the subject of magnetism, and magnetic condensation do not appear to be well known; he recapitulates the results he has at various times proved experimentally, in order to assert that he was the first to demonstrate years ago some of the phenomena M. Lallemand has written about. He says, among other things, I will commence by stating that the words *magnetic condensation*, which I was the first to use (possibly slightly improper), since it takes for granted in the phenomena an *increase* of magnetic energy which should maintain itself independently of the magnetising cause, but which, in reality, disappears with it, only giving place, *after* this disappearance, to a secondary magnetic action (variable according to the energy of the developed magnetisation), which has this time all the characteristics of a condensing action. Now it is precisely on account of this secondary magnetic action, and of the strengthening of this magnetic action itself, that I have

given the name of *magnetic condensation* to the phenomenon. We may indeed, in this action, meet with all the effects produced by an electric condenser. Thus the polarities excited on the surface of contact of two magnetic pieces, by reason of mutual reaction maintain each other after the magnetising cause has been removed; and to cancel the effect, it is necessary to separate the two pieces, or destroy one of the two polarities by an exterior contrary magnetism.

On the Decomposition and the Preservation of Woods.—M. Max Paulet.—It is generally admitted that the preserving action of metallic salt injected into timber is due to its combining with the ligneous tissue, and especially with the nitrogenous matter, whereby it is rendered insoluble and poisonous to organic creatures. *This explanation is insufficient;* for, from careful experiments with metallic salts, especially with copper, it is proved: (1.) That the albumino-cupric precipitate is not absolutely insoluble in water; (2.) That it is above all soluble in water charged with carbonic acid. The nitrogenous matter contained in ordinary wood is partly soluble and partly insoluble. The soluble albuminous portion is fixed by the metallic salt, which is thus united to the insoluble nitrogenous matter. Water, especially when charged with carbonic acid, dissolves and takes away the metallic agent. Recent experiments show that the reactions are not always so simple. The following is an instance of what is more often remarked: A "beech" sleeper injected with sulphate of copper, after having been buried for eight or ten years, is found to be rotten in several places. The altered parts are very brown in the neighbourhood of the rail; the wood is not worm-eaten, but chemically altered. If it no longer perceptibly contains copper, it does contain quantities of rail-iron. The fact of the iron penetrating into the wood, whilst in a state of dissolution, clashes with accepted ideas on the subject. The density of the wood is found singularly diminished. The difference in density between the sound and unsound portions are respectively 0·755 grain and 0·380 grain. The altered portion contains nitrogenous matter; it entirely dissolves in caustic potash; and, treated with water slightly nitrous, it gives up the lime it contains, as also a large quantity of iron. This iron, which could only have permeated the wood during its state of dissolution, is now insoluble; likewise, cyano-ferric solution of potassium, when applied to a chip of it, does not colour it blue. Whilst the nitrous acid takes away the iron, a prolonged disengagement of carbonic acid is perceived, a quantity much greater than contained in wood altered by exposure to the air. The explanation of the destruction of the wood is that the carbonate of lime contained in the ballast, and become soluble in an excess of carbonic acid, gradually penetrates the timber, at the same time driving out the copper. It suffices merely to measure the degree of alteration of the wood to determine the quantity of carbonic acid, or carbonates which it contains. The tenacity of the fibres is consequently inverse to the proportion of carbonic acid they contain. Carbonate of lime is not a septic agent, but by its combinations it eliminates the preserving action of the metallic salt, by interposing itself between the conserving matter and the matter to be preserved. In confirmation of this is the known fact that sleepers are rapidly destroyed in chalky ground.

No. 2. January 11, 1875.

On Stratified Light.—M. Neyreneuf. Herein the author desires to show by recital of experiments that a regular system of oscillations is in no way incompatible with the propagation of a rapid flow of heat and light, susceptible to energetic mechanical actions.

No. 3. January 18, 1875.

Contains nothing relating to the science of electricity.

Correspondence.

DERIVED CIRCUITS.

To the Editor of the Telegraphic Journal.

SIR,—In No. 43 of your Journal, published Nov. 15th, a formula is given for ascertaining the combined resistance of a system of derived circuits composed of three wires, two being joined at their extremities parallel to each other,—the third forming a bridge from one to the other, but connected at points of unequal potential so as to convey a current across the system from one parallel wire to the other. In such a case, how much is the combined resistance of the parallel wires lessened by the application of the cross or bridge wires?

It may interest some of your readers to know that a solution of this problem was given in a paper communicated to the Royal Society (No. 125 of 1871).

In the paper referred to, the solution is obtained without the assistance of Kirchoff's laws, and the formulæ are given for finding the shunt power for any particular branch in the figure.—I am, &c.,

HENRY C. MANCE.

Kurrachee, January 1, 1875.

Our Exchange.

ALL letters must be addressed to the publisher. The column is *free* to subscribers. Non-subscribers pay 6d. for each entry of twelve words, and 1d. for each additional two words. Price in figures counts as one word. Applications, accompanied with stamps and names and addresses, must be sent to the publisher. It is preferred that communication should, as much as possible, be maintained between seller and buyer.

The column is intended to be the vehicle of the expression of wants in books and apparatus, and of a means to supply those wants.

WANTED.

A good second-hand induction coil, giving not less than 6-inch spark; state lowest price.—Electro Magnet, 1, Home Road, Battersea.

Spon's "Dictionary of Engineering."—A 1.

Box of resistance coils.—A 2.

POST-OFFICE TELEGRAPHS.—Statement showing the total number of messages forwarded from Postal Telegraph Stations in the United Kingdom during the week ended the 30th January, 1875, and during the corresponding week of 1874:—1875, 339,733; 1874, 368,315; decrease in the week of 1875 on that of 1874, 28,542. The unusually high number of messages for the corresponding week of 1874 was caused by the preparations for the general election.—Week ended 6th February, 1875, and corresponding week of 1874:—1875, 342,892; 1874, 367,176; decrease in the week of 1875 on that of 1874, 24,284. The high number of telegrams during the corresponding week of 1874 was owing to the general election.

To Correspondents.

MR. EDEN, of Edinburgh, has addressed us on some remarks contained in Mr. Daniell's Address to the Telegraph Electrical Society of Melbourne, based upon a passage in one of Mr. Preece's lectures. The meaning is very clear—that those who make their business a profession are more likely to succeed than those who do not, and therefore pecuniary advantage must eventually accrue to those who study and think for themselves. Mr. Eden has only to refer to the officers of his own Department to find this proposition fully verified.